APRIL/MAY 2023

GPH13/DPH13 — QUANTUM MECHANICS – I

Time : Three hours Maximum : 75 marks

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SECTION A — (10 × 2 = 20 marks)

Answer ALL questions.

1. Give the admissibility conditions for a wave function.

2. Define Normalisation.

3. Mention the significant properties of unitary transformations.

4. Write down the expectation values of $<p>$ and $<\frac{p^2}{2m}>$.

5. How symmetry and conservation laws are related?

6. What is zero point energy of the harmonic oscillator?

7. What do you understand by parity?

8. What are continuous symmetries and discrete symmetries?

9. Write operators associated with angular momentum.

10. What are ladder operators? Why are they called so?

SECTION B — ($5 \times 5 = 25$ marks)

Answer ALL questions.

11. (a) Explain conservation of probability.

Or

(b) Obtain time independent Schrodinger wave equation.

12. (a) Deduce the equation of motion in momentum representation.

Or

(b) Outline Dirac's bra and ket notation.

13. (a) Explain symmetry transformations.

Or

(b) Solve harmonic oscillator problem by the operator method.

14. (a) Explain spatial translation and time translation.

Or

(b) What do you mean by expectation value of an observable explain the mathematics for the same.

15. (a) Write a note on Clebsch-Gordan coefficients.

Or

(b) Prove that (i) $J \times J = i\hbar J$ and (ii) $[J^2, J] = 0$.

SECTION C — ($3 \times 10 = 30$ marks)

Answer any THREE questions.

16. Discuss the eigen value problem for a particle moving in a one dimensional square well potential.

17. Explain the General uncertainty principle.

18. Obtain the equation of motion in Heisenberg representation.

19. What are density matrices? Explain their properties. Discuss about pure and mixed density matrices.

20. Find the eigen value and eigen function corresponding to J^2 and J_z operators.
